sition of vectors were assumed outright. The author is probably now the only surviving writer on dynamics who persists in muddling up force and acceleration by calling acceleration (a purely kinematical quantity in itself) an "accelerating force," and he adds to the muddle by writing $v = ft$ where all modern writers would put $v = at$. What the student is to understand by "a force capable of generating in one second a velocity represented by DE" (p. 27) is difficult to see, when the mass on which the force is to act is nowhere stated, and when it is not even stated or hinted that there is any mass at all to be acted on. On p. 41 the author states that "in this country the ounce avoirdupois is so taken that one thousand of them will just balance a cubic foot of distilled water." This is not so, at least in *this* country, for the mass of the ounce depends on the standard pound, and this was established without any reference to a standard volume of water. The definition is wrong; the fact it states is a mere coincidence; and the coincidence itself is not exact: a cubic foot of water does *not* weigh 1000 ounces. On the same page the author tells the reader to ascertain with respect to a certain mass the velocity which "a given pressure or impulse" will impress upon it; "the mass being inversely proportional to this velocity." The confusion between *pressure*, which cannot be expressed except in terms of force divided by area, and *impulse*, which is expressed as force multiplied by time, is truly amazing. Is time the reciprocal of an area? Again, on page 42 the author is speaking of a certain force capable of sustaining a certain weight for one second of time, and he says "it would require twice as powerful a force to enable it to resist the action of gravity for two seconds, three times for three, and so on." This is news indeed. In the section on hydrostatics, no sooner has the student learned that a pressure of one pound per square inch is equal to 100 lbs. per 100 square inches, than he comes to such a statement as the following (p. 52): "The pressure therefore exerted by a mass of fluid upon the bottom of a vessel containing it is proportional to the area of the base," &c. Here the author jumps, without one word of warning to the student as to his change in the use of words, from using the word pressure in its proper sense of so many *pounds-per-square-inch*, to using the word in the sense of so many *pounds*, in which case it is no longer a "pressure" but a "force." It may be said perhaps that these things are but slips of the pen. Perhaps they are; but in a teacher who undertakes to write a text-book of "first principles" slips of such a kind are unpardonable. No such confusion of thought would be tolerated in the pupil who had read Wormell's "Dynamics," or Lodge's "Mechanics," or Maxwell's "Matter and Motion," or Thomson and Tait's lesser volume. If Mr. Lynn does not intend his text-book to be cast aside as worse than useless, he must at once correct blundering modes of thought that can only mislead the student.

Eléments de Mécanique, avec de nombreux Exercices. Par F. I. C. Pp. 282. (Paris: Poussielgue Frères.)

THIS is the concluding volume of a series of elementary class-books on pure and applied mathematics issued by l'Institut des Frères Écoles chrétiennes, a French Society which showed in the Technical Schools at the recent Health Exhibition a noteworthy collection of specimens of work done in their schools, along with the educational apparatus used therein.

The character of the book before us harmonises with the evident sympathy of the Society with the manufacturing industries of the districts in which their schools are situated. We are furnished with an introduction to applied as well as to theoretical mechanics. There are good diagrams and descriptions of weighing-machines, cranes, and other lifting-tackle in the section on statics; the longest chapter in kinematics is concerned with the simpler forms of mechanism; and in dynamics there is a full discussion of the principle of work and its application to mechanics.

The text is clear, as far as it goes; but we think the general exposition of the theory too concise, many important points being relegated to the exercises at the end of each chapter.

There is a good collection of problems filling the last fifty pages of the book, but no examples are worked out in the text, and there are no results given to any of the exercises. Clearly, pupils using the book would require a good teacher at hand, who could devote ample time to the subject.

We should wish to see a book like this with a few select students, but, having regard to general class instruction, we do not think the mode of treatment a happy one. We feel called upon, however, to give a cordial recognition to the expansion in the direction of technical instruction, to the liberal supply of good diagrams, and to much freshness of treatment, both in text and examples, in the work before us. A. R. W.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Chemical Research in Great Britain

AT the anniversary meeting of the Chemical Society held March 31, 1884, the President read an address to the Fellows, which contains a series of remarks upon the prosecution of original research in England requiring some notice, particularly as a separate issue of the address has been circulated by the author. Attention is directed to the fact that we have an increased number of laboratories in Great Britain[1] and greater facilities for the prosecution of research through the aid of the Government grant and the Chemical Society's fund. Notwithstanding this the startling and anomalous fact is to be observed that the number of papers read before the Society is declining year by year.

After speaking in terms of praise of the degree of Doctor of Philosophy of Germany, which necessitates the prosecution of some original investigation, there follow some remarks which read like a serious reflection on a number of professors who have won distinction through unremunerative devotion to scientific teaching and research.

"The past neglect of research will, it is to be feared, have a more lasting influence on the progress of chemistry in this country than may appear at first sight, and in this way. Those who have been students in laboratories where the importance of this kind of work is not recognised, advance in their positions, becoming assistant demonstrators, &c., and eventually professors, and as they have not learnt to practically realise the value of research by being in the habit of conducting it themselves, or of seeing others do so, when they become professors they will naturally not encourage students to undertake it in their laboratories, and it is to be feared that we are already suffering in this way, and that this is one of the causes why the new laboratories which have been opened are doing so little to add to our store of fresh knowledge."

It will be questioned whether such a statement can be justified when it is mentioned that there happens to be lying on the table before the writer four reprints of papers recently received from the respective Professors of Chemistry in four of the new colleges; three of these memoirs are published in the *Philosophical Transactions* of the Royal Society, while a fifth occupant of one of the newly created chairs not long since received the Longstaff Medal. The whole subject seems scarcely to have been so well considered as to lead to a just appreciation of the cir-

[1] The term used is the United Kingdom, which includes Ireland. There has been no increase in the number of laboratories in Ireland, and only an increase of one in Scotland.

cumstances which give rise to unfavourable comparisons between scientific work in Great Britain and on the Continent.

But let us deal with the decline in the number of contributions to the Chemical Society. In 1880-81 there were 113 communications; in 1881-82, 87; in 1882-83, 70; and in 1883-84, 67. To what may this decline be assignable? In the first place the Chemical Society is not the only body in the United Kingdom which publishes papers on chemistry; there are the Royal Society of London, the Royal Society of Edinburgh, and five others, including the important Society of Chemical Industry. There are two societies in Dublin, but in this discussion Ireland will be left entirely out of the question. Causes not easily definable may lead to the transfer of authors' works to one or other of these bodies instead of to the Chemical Society, In fact these figures inform us that as the Society of Chemical Industry sprang into being and increased in importance so did the number of contributions to the Chemical Society diminish, and those to the younger body increase. We find that in 1883-84, the second year of its existence, there were sixty-eight papers read at the meetings of the Society of Chemical Industry, and the President will probably have to congratulate the members upon a still further increase at the next anniversary meeting. This is not all; the number of papers is no criterion of the excellence of the work done, and it may be maintained that the importance of the published communications has very distinctly increased, and if this be admitted it is self-evident that with increased elaboration, provided the same amount of work be expended, numerical decline must follow. In comparing the number of papers published in the *Transactions* of the Chemical Society with those in the Berlin *Berichte*, there is also an element of unjust reckoning, inasmuch as the latter volume includes the work of chemists not only distributed throughout the whole German Empire, but of many natives of eight other countries of Europe, occasionally a contingent from America, and even one or two from England. A strict examination will show that our shortcomings are scarcely so considerable as they appear from the President's representation.

Let us now consider what influence on original work may be expected from an increased number of laboratories and colleges. It is made to appear as if the fault which renders comparisons unfavourable to us lies entirely with the teachers. This is unwarrantable because, for the amount of instruction given, the proportion of professors and lecturers in Great Britain is much smaller than in Germany. Courses of lectures on theoretical chemistry—inorganic and organic—metallurgy, and applied chemistry, are not unusually required from one professor, who sometimes in addition is expected to lecture at night to artisans. In one or two cases he has to treat of physics, and is styled the Professor of Chemistry and Physics. Such labour would never fall to the lot of any German professor. For the sake of brevity all reference to the paucity and insufficiency of the endowment of the chairs may be omitted, as likewise the motives for study which influence the attendance in the new colleges.

It may well be doubted whether the President of the Chemical Society had earnestly sought to make himself acquainted with the course of instruction pursued in most English laboratories, and realised the difficulties in the prosecution of research by students which are known only to teachers. Medical students, for instance, pay their fees for a certain well-defined course of instruction, and always see that they get it. The lecturers and professors in other colleges, such as those recently established, would neglect their duty if they did not follow out the programme of studies drawn up by the respective Boards and Councils. The town councils, associations of manufacturers, and public-spirited gentlemen who establish the new colleges have been taught to believe that our manufactures and scientific industries are languishing for want of technical education, which must be supplied to masters, superintendents, foremen, and workmen. Their schemes of education are based on the requirements of such a class of students, and they are bound to comply with the demands made upon them. Hence it arises that a three years' course of study is devoted to mathematics, mechanics, drawing, physics, chemistry, and engineering. Chemistry in England is either a branch of general education, a professional, or a technical study, but seldom is it pursued for its own sake. From upwards of 1000 students taught in the laboratories of a single college during a period of nine years, only seven men can be counted who prosecuted their studies with any idea of making themselves chemists, and of these, five were the authors of researches pursued during their college career, which were published in the Chemical Society's *Journal*.

In the German Empire there are twenty-two Universities, all departments of the State, with professors, lecturers, demonstrators, assistants, buildings, and laboratory equipments provided and maintained by funds from the respective Governments. There are about two thousand teachers and twenty-five thousand students annually pursuing all branches of learning. Science, and experimental science especially, is valued to the same extent as classical and mathematical training in England; chemistry especially receives great attention, as is shown by the fact that the above figures include one hundred and twenty professors of chemistry, sixty of whom are "ordentliche Professoren." The cause of this has been attributed by some to the teachings of Liebig and those of his school. The result is that a student occupies himself with the most recondite branches of chemistry, physics, and cognate subjects, without having in view any immediate application of his knowledge or research either to the requirements of a professional career or those of a scientific industry. This is shown by the period spent at the University being longer than is necessary for such a purpose. Tradition has placed the learning of the schools of Oxford and Cambridge on a higher platform than that of science, and we cannot alter in thirty years that which has existed in men's minds for more than three centuries,[1] unless indeed we can call to our aid an intellect like that of Liebig placed in a position of great influence. It would, however, be a national misfortune if other branches of learning were to suffer for the benefit of science.

The recently-established colleges in the manufacturing districts differ from the Universities, and are more nearly allied to the special schools or Polytechnics of the Continent; but, in addition to providing the education of such establishments, they have to perform the functions of University colleges, of medical schools, and frequently also of superior mechanics' institutes, generally with a staff inadequate for the purpose. For the most part knowledge is acquired in such institutions only to serve as an aid to improving manufactures. There are on the Continent, not counting France, eleven Polytechnics, or high schools, built at a cost of not less than three millions sterling, and maintained by an annual expenditure of 200,000*l*. In "Les Allemands," by Le Père Didon, it is remarked that the prosperity of highly-cultivated nations depends upon the prosperity of the special schools and the Universities together, but there is a danger when the prosperity of the former leads to a decline in the popularity of the latter. In the work quoted, England is cited as an example of the inconveniences that arise from a want of equilibrium between professional education and the more theoretical and speculative teaching of the Universities. The dominating studies of classical literature, pure mathematics, philosophy, history, and theology of Oxford and Cambridge cause students of the middle class too frequently to pass at once to the professional colleges of medicine, engineering, &c., instead of educating professional men up to that level of general knowledge without which the most able specialist is wanting in a great essential to success in life.

That originality of thought is fostered and cultivated at the German Universities is an undoubted fact, but the requirements of the degree of Doctor of Philosophy cannot be entirely credited with this; it is rather that which is not required which is so advantageous to students. It is the *Lehre und lern Freiheit* which professors and pupils both enjoy; the professor has time for thought, and is not hampered by having to consider whether that which he teaches must be a suitable preparation for the pupils' various examinations, while the student, on the other hand, is not harassed by having to devote time and attention to uncongenial studies.

On the Continent the motive for scientific education is mental culture, while in Britain it is utilitarianism; while the former tends to the *advancement of learning*, the latter involves nothing further than the *diffusion of knowledge*. Hence the utilitarian principle neutralises in a great measure the advantages of an increased number of colleges, improved laboratories, and possibly of money-grants in aid of research.

The debased utilitarian view of the advantages of studying science is spread throughout the whole of this address, and it would be deplorable if all the presidents of the learned societies

[1] Bacon says ("Aphorisms," Book I. xc): "Again, in the habits and regulations of schools, universities, and the like assemblies, destined for the abode of learned men and the improvement of learning, everything is found to be opposed to the progress of the sciences.

preached an annual sermon from the same text. It is certain that the sympathies of the public would be alienated; and if those hearers who are taken to task were to follow consistently the lesson inculcated, they would occupy themselves entirely with objects of pecuniary gain instead of providing the discoveries which our manufacturers are so much in need of, or advancing learning by their contributions to the *Philosophical Transactions.*

W. N. HARTLEY

Our Future Watches and Clocks

IN reference to the note on this subject in NATURE (p. 36), it appears to me that to any radical change in dial-division there exist many objections, of more or less weight, over and above those already enumerated. In regard to—

(*A*) *Striking the hours.*—(1) It is said that "public clocks . . . could not go on to twenty-four." The same would apply to private clocks as well, as the higher numbers would be struck during the—to children and many others, sick or well—early hours of sleep, when greater disturbance from house clocks than at present occurs would be quite unendurable. The counter-advocacy of silent house clocks would scarcely meet the case.

(2) The alternative suggestion of "one stroke only at each hour" would do away with one important function of public clocks, that of marking to watchless people the exact hour. Persons abed, lonely watchers, and field-labourers, commonly depend upon the church clock for information which could only be acquired otherwise with much discomfort.

(*B*) *The 24-division plan.*—(3) That no diminution in "the angular motion of the hand" during any given time should be brought about seems most vital. The time of day is often obtained from far-distant clocks, and is even at present not easy to decipher readily, especially under circumstances of inadequate light or visual power.

(4) Similarly, in the case of any slight looseness in the hands —a commonly-neglected chronometric infirmity—it would be harder than ever to decide at a glance what hour is indicated.

(5) It will be observed that the adoption of this plan would almost necessitate half-minute arcs.

C) *The double 12-division plan.*—(6) Inasmuch as the presence of two concentric circles of figures of undiminished size would shorten the clear effective length of the hands, the arc subtended by the hourly angle would be diminished by much the same extent as in the previous plan (*B* 3), and a similar objection would apply.

(7) The presence, in any form, of twenty-four symbols, in addition to the maker's name and the like, in the dial area, especially in ladies' time-pieces, would be eminently confusing, and restrictive of instantaneous decision as to what the time may be.

8. Even if, to obviate all this—a point suggested by the statement that "persons probably pay small attention to the figures"—a single circle of twelve conventional symbols, identical or not, such as a radial arrowhead, were adopted to indicate the a.m. and the p.m. hours in their turn, one would have to undergo the added mental labour of deciding the actual *number* of the hour.

(9) In any case the introduction of a "o" hour, unless we are to adopt railway phraseology, would be most awkward, and in the "double 12-division plan" the transition at noon and midnight from one circle to the other would not be a simple sequence.

Finally, the question arises whether the now common time-pieces, in which the hands are either replaced or supplemented by a series of peep-holes, wherein the minute, hour, and even week-day for the time being, are consecutively displayed, would not aid the introduction of the twenty-four hour system into rough general use. The main disadvantage of abolishing the hands is that one would lose an actual picture suggestive of the time which will elapse between the present and any point in the near future. For all purposes for which closer chronometric accuracy is required, the above stumbling-blocks to change in dial-division, arising out of the pressing value in ordinary life of the ability to tell the time swiftly, and without undue mental effort, would be swept away.

ERNEST G. HARMER

88, Buckingham Road, N., November 19

As regards the practical question how clocks are to be made to strike if the dial is to show twenty-four hours, I have a suggestion to make.

But firstly, the convenience of beginning the day at midnight is evident, as the early morning hours are those which it is most useful to have indicated to the ear, and our clocks may continue to strike from 1 a.m. to 6 as now.

The inconvenience of having to count any number of strokes above six is so great, and doing it so tedious, that most persons break down in attempting it with a slow-striking clock; and I think that there is a good deal to be said for the system, which obtains in some places where the hours are still reckoned as twenty-four, of beginning afresh at the end of every six hours, and denoting 7 and 13 as 1, &c. This plan would make very little or no change.

But what I wished to suggest is: That clock-makers should make the clocks to beat the strokes in pairs; *e.g.* two strokes and a rest + two strokes and a rest + one stroke, would be 5. This would be counted as easily as 3. Moreover, there would be no occasion under ordinary circumstances to count the strokes at all; whether the hour was *odd* or *even* would be all it was necessary to learn for one to know which hour it was of the twenty-four. One may, for instance, in the morning doubt whether it is 10 or 11, or whether it is 11 or 12, but one rarely doubts whether it is 10 or 12. And on the principle I recommend, the last stroke of the clock being single or double would decide the matter. One would not even have to attend to it. I contend that under the present system it is impossible for a person with only ordinary patience to discover whether a clock strikes 11 or 12.

If you think anything of this suggestion, which I have always thought myself to be a fair solution of a difficulty, I shall be glad if you would insert it in your paper.

R. B.

Lightning-Conductors

IN the *Edinburgh Review* of last July many of your readers will probably have noticed an article on "Lightning-Conductors," written somewhat strongly from the point of view of an advocate of the apparatus thus popularly designated. Perhaps a few words of comment on this paper from a rather different aspect may not be without interest to those who are able and willing to treat the subject with unprejudiced minds.

In the reviewer's narrative of the history of lightning-rods he omits all mention of Franklin's initial letter of September 1, 1747—that letter in which the great discovery of the power of points is given to the world. But it is abundantly evident from his subsequent letters of 1749 and 1750, in which he definitely forecasts the invention of rods, that it was to his knowledge of this power—and of this power alone—that he owed the idea of these instruments. In other words, his original conception was purely that of an apparatus for *preventing* the occurrence of a lightning-stroke at the place where the rod was erected. Now, if I am not mistaken, the reviewer from first to last never alludes to this all-important function. It is true that Franklin himself afterwards fell in with the curious supposition that these rods acted as "conductors" of a stroke. But (so far as can be judged from his letters) this was not till September 1753, at which time most of the European scientific men, themselves either ignorant or sceptical of the preventive power of points, had fully adopted the invention and had invested it with the theory, that has ever since been accepted, of its being a means of "conducting" past the building a stream of fiery matter (denoted as "electric fluid") descending from the clouds to the ground. Now it is evident that nothing can conduct the agency known by us as "lightning" without first being struck by it; and it is also manifest that, in order to be so struck, an object must present some "attraction" to the stroke. This attraction—this necessary first step to conduction—allowing for the nonce that an explosion such as constitutes a lightning-stroke *can* be conducted—is a matter that usually (and not unnaturally) is treated by those who believe in lightning-rods with some little reticence. I therefore think it is but fair to give credit to the reviewer for the open and honourable manner in which he enunciates his views of the true function of lightning-rods. He says (p. 40):—"Conductors provided by engineering art are *intended* to be struck, but struck in such a manner as to govern the lightning and to render the heaviest strokes harmless." There is no beating about the bush. He admits that his conductors are purposely fixed on a house in order to attract a stroke to that house with the view of afterwards rendering the effects of the explosion nugatory. Now the very essence of the opposition that has been made to the use of these conductors lies in this very fact of